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The Role of Ultrasound Indicators in Managing Pregnant Women with Premature Rupture of Membranes

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ABSTRACT

Background & Objective: Premature Rupture of Membranes (PROM) occurs in 2 to 3% of pregnancies. Previous evidence suggests that ultrasound markers can be used to manage PPROM. The present study was conducted with aim to investigate the role of ultrasound markers in managing pregnant women with PROM.

Materials & Methods: This descriptive-analytical study was conducted in 2022-2024 on 99 pregnant women diagnosed with PROM at gestational ages of 24 to 34 weeks who referred to tertiary hospitals. For all participants, ultrasound parameters including biometry, uterine artery Doppler, umbilical cord and Middle Cerebral Artery (MCA), Biophysical Profile (BPP), and Amniotic Fluid Index (AFI) were measured at the beginning of admission and repeated twice a week. Maternal and neonatal outcomes were recorded in a researcher-made checklist. All patient information was analyzed using SPSS (version 24) and Chi-square test (for correlation between qualitative variables) and T-test (for correlation between quantitative variables). $P<0.05$ was considered statistically significant.

Results: The mean age of pregnant women was 29.78±6.84 years, with a mean gestational age of 31.22±4.23 weeks. The route of delivery was cesarean section in 59 (59.6%) women. It was also found that there was a reverse significant relationship between the umbilical artery index and first minute ($P=0.029$) and fifth minute ($P=0.043$) Apgar score.

Conclusion: In pregnant women with PROM, the ultrasound index of the umbilical artery can be used for neonatal outcome management.

Keywords: Ultrasonography, Doppler, Preterm premature rupture of membranes, Pregnancy outcome

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1. Introduction

Premature Rupture of Membranes (PROM) occurs in 2 to 3% of pregnancies and is responsible for about one-third of preterm labor **(1)**. The prevalence of PROM varies in different regions, with Ethiopia reporting 13.7%, Uganda 7.5%, Egypt 5.3%, Nigeria 3.3%, China 2.7%, and United States reporting 1.4% **(2-5)**. Various etiologies have been proposed for PROM, and chorioamnionitis has been detected in more than 50% of cases **(2)**. On the other hand, some studies have reported an association between systemic infections, including genitourinary tract infections or bacterial vaginosis, with an increased risk of PROM **(3)**.

The occurrence of PROM, regardless of its etiology, is an important challenge in pregnancy and requires fast and timely diagnosis and therapeutic interventions. Indeed, appropriate treatment can significantly reduce neonatal morbidity and mortality, such as pulmonary and cerebral complications **(4,5)**. Pregnant women diagnosed with PROM between 24 and 34 weeks of gestation should be immediately hospitalized for close maternal and fetal monitoring **(6)**. Monitoring markers

can be clinical or non-clinical, such as the presence of fever, uterine tenderness, vaginal discharge, tachycardia (maternal or fetal), leukocytosis, positive nitrazine, or the Ferning or AmniSure test, which have low sensitivity and increase the risk of infection **(7)**.

The ultrasound markers may be helpful for increasing sensitivity. The most important ultrasound markers include Nonstress Test (NST), Biophysical Profile (BPP) (which assesses Fetal tone, movements, and breathing movements, as well as amniotic fluid volume), umbilical artery Doppler, uterine artery Doppler, and cerebral artery Doppler **(8-10)**.

Given the importance of the issue and the lack of sufficient scientific documentation in this regard, the present study was performed with aim to investigate the role of ultrasound markers in managing pregnant women with PROM.

2. Materials and Methods

This descriptive-analytical study was conducted on 99 singleton pregnant women diagnosed with PROM between 24 and 34 gestational weeks who referred to tertiary hospitals affiliated with Tehran University of Medical Sciences from March 2022 to March 2024. Inclusion criteria were singleton pregnant women diagnosed with PROM between 24 and 34 gestational weeks. Exclusion criteria were the presence of any ongoing maternal infection, underlying maternal diseases, uterine artery disorder before the 24th week of pregnancy, IUGR or anomalies in fetuses, and the occurrence of delivery in less than 48 hours from admission, as well as the unwillingness to participate in the study.

All eligible pregnant women were admitted and underwent monitoring with ultrasound parameters, including biometry, uterine artery Doppler, umbilical cord, Middle Cerebral Artery (MCA), Biophysical Profile (BPP), and Amniotic Fluid Index (AFI). These parameters were evaluated upon admission and then repeated twice a week.

According to the routine protocol, all pregnant women received corticosteroids along with antibiotics for 7 days. Betamethasone was administered 12 mg orally and repeated for 24 hours, followed by antibiotic prescriptions of ampicillin 2 g intravenously every 6 hours for 48 hours (and then converted to oral ampicillin 500 mg orally every 6 hours for 5 days), and erythromycin 400 mg orally every 6 hours for 7 days **(11)**.

The last ultrasound data was analyzed. Neonatal outcomes included umbilical cord PH and Apgar score at birth, incidence of sepsis, respiratory distress syndrome, neonatal seizures, neonatal intensive care unit admission, IVH, or neonatal mortality.

Data were analyzed using SPSS (Statistical Package for Social Science) software (version 24) and descriptive statistics, including mean, standard deviation and relative frequency. Moreover, Chi-square test (for correlation between qualitative variables) and the T-test (for correlation between quantitative variables) were used. $P<0.05$ was considered statistically significant.

3. Results

Among 99 patients examined, the mean age of women was 29.78±6.84 years, and the mean BMI was 23.63±4.96 kg/m^2. The mean number of pregnancies was 2.32±1.39 times, and the mean gestational age at rupture of membranes was 32.28±4.30 weeks. The mean umbilical artery index was 1.12±0.34, and the mean amniotic fluid volume was 8.77±4.78 ml. Demographic, clinical, and paraclinical history of patients is shown in Table 1.

Table 1. The demographic, clinical, and paraclinical information

Parameters	
Age (years)	29.78±6.84
Gestational age at rupture of membranes	32.28±4.30
Body mass index (kg/m2)	23.63±4.96
Presence of underlying diseases	48(48.5)
History of cervical cerclage	9(9.1)
length of cervix (mm)	23.22±7.84
Cesarean section delivery	59(59.6)
1-minute Apgar	7.02±2.13
5-minute Apgar	8.32±1.93
Neonatal weight	2030.25±532.59
Neonatal respiratory distress syndrome	38(38.4)
Neonatal sepsis	6(6.1)
Neonatal intraventricular hemorrhage	3(3.0)
Neonatal death	9(9.1)
Neonatal hospitalization day	1.65±1.02
Amniotic fluid volume	8.77±4.78
Abnormal biophysical profile	4(4.0)
Abnormal non-stress test	3(3.0)
Umbilical artery index	1.12±0.34
C-reactive protein	14.71±25.06
White blood cell count	11301.92±2950.91
Cerebral artery index	1.79±0.36
Erythrocyte sedimentation rate	45.11±16.32
Neutrophil-to-lymphocyte ratio	76.93±5.81

The route of delivery was cesarean section in 59 (59.6%) women. Overall, 38 infants (38.4%) had RDS, 6 (6.1%) had sepsis, and 9 (9.1%) died. There was a significant relationship between PI and first-minute (P=0.29) and fifth minute (P=0.043) Apgar score, but no significant relationship was found with other neonatal variables. In addition, examining the relationship between neonatal outcomes of delivery and amniotic fluid volume revealed no significant correlation (Table 2).

Table 2. Studying the relationship between neonatal outcomes and average amniotic fluid volume

Variable		Amniotic fluid volume (ml)			P-value
		Mean±SD	Min	Max	
Neonatal sepsis	Negative	8.52±4.61	0	20	0.176
	Positive	12.55±6.22	2	22	
	Total	8.77±4.78	0	22	
Neonatal respiratory distress	Negative	9.24±4.59	1	21	0.228
	Positive	8.01±5.04	0	22	
	Total	8.77±4.78	0	22	
Neonatal cerebral hemorrhage	Negative	8.63±4.60	1	20	0.472
	Positive	13.20±9.01	0	22	
	Total	8.77±4.78	0	22	
Neonatal hospitalization	Negative	6.00	-	-	0.934
	Positive	8.97±7.53	1	22	
	Total	8.97±4.78	0	22	
Neonatal mortality	Negative	9.17±4.48	0	22	0.342
	Positive	8.22±5.16	1	21	
	Total	8.77±4.78	0	22	
1st minute Apgar	8-10	7.81±4.80	1	22	0.392
	<8	1.65±1.02	0	21	
	Total	8.77±4.78	0	22	
5th minute Apgar	8-10	8.95±4.78	1	22	0.392
	<8	7.81±4.80	0	21	
	Total	8.77±4.78	0	22	
Umbilical cord pH	≥7.30	8.77±4.86	0	22	0.981
	7-7.29	8.75±4.57	1	21	
	<7.29	6.89	-	-	
	Total	8.77±4.78	0	22	

Table 3. Studying the relationship between neonatal outcomes and average umbilical artery index (PI)

Variable		Umbilical artery index (PI)			P-value
		Mean±SD	Min	Max	
Neonatal sepsis	Negative	1.12±0.34	0.09	2.76	0.510
	Positive	1.22±0.34	0.1	2.70	
Neonatal respiratory distress	Negative	1.14±0.40	0.11	2.76	0.554
	Positive	1.10±0.21	0.09	2.73	
Neonatal cerebral hemorrhage	Negative	1.12±0.40	0.09	2.76	0.733
	Positive	1.20±0.33	0.15	2.75	
Neonatal hospitalization	Negative	1.13	-	-	0.849
	Positive	1.08±0.24	0.09	2.76	
Neonatal mortality	Negative	1.12±0.35	0.09	2.75	0.866
	Positive	1.13±0.18	0.12	2.76	
1st minute Apgar	8- 10	1.06±0.25	0.09	2.76	0.029
	< 8	1.22±0.42	0.15	2.75	
5th minute Apgar	8- 10	1.08±0.29	0.09	2.74	0.043
	< 8	1.35±0.48	0.12	2.76	
Umbilical cord pH	≥7.30	1.13±0.35	0.1	2.76	0.581
	7-7.29	1.09±0.27	0.09	2.76	
	<7.29	6.89	-	-	

4. Discussion

The results of the present study showed that the mean age of the patients was 29.78±6.84 years, and the mean gestational age was 31.22±4.23 weeks. In addition, 59 (59.6%) women had a cesarean section, and the rest had vaginal delivery. Regarding neonatal complications, 38 (38.4%) infants had RDS, 6 (6.1%) had sepsis, 3 (3.0%) had IVH, and 9 (9.1%) died. It was also found that there was a significant relationship between PI and Apgar scores at first minute and fifth-minute Apgar scores. No significant relationship was found with other variables such as amniotic fluid volume and neonatal outcomes. These findings are consistent with those of other studies **(30,31)**.

The cause of PROM is not always clear. However, infection, placental disorders such as placental insufficiency or retroplacental hematoma are the most important causes. Other factors of PROM include a history of preterm labor, vaginal bleeding during pregnancy, direct trauma to abdomen, cervical surgery or a short cervix, a history of placental abruption, increased amniotic fluid volume, and multiple pregnancies **(32)**.

The most common complications of premature PROM include preterm delivery, postpartum septicemia, RDS, pulmonary hypoplasia, umbilical cord prolapse, and chorioamnionitis **(33,34)**.

Singh et al., showed that there was a significant relationship between Doppler indices and the variables of umbilical cord pH, gestational age, first-minute Apgar score, type of delivery, and myometrial thickness **(35)**. Their results were somewhat consistent with the findings of the present study. The reason for the lack of complete agreement could be related to study design, patient selection, or differences in sample size of the studies.

Abdallah et al., also showed that cervical length indices and type of delivery can help diagnose PROM through ultrasound indicators, but they did not find a significant association with neonatal outcomes **(36)**, which is like the present study.

Amniotic fluid measurement is directly dependent on the experience of the sonologist, and factors such as the presence of fetal organs in the fluid sac, the condition of the fetal bladder, and other factors affect the result **(37)**.

In a study by Wolde et al., it was found that the rate of PROM was significantly associated with a history of miscarriage, uterine manipulation, and urinary tract infection during pregnancy **(38)**.

Telayneh et al., showed that multiple pregnancy, polyhydramnios, and uterine manipulations such as cerclage and uterine anomalies are important associated factors with PROM **(39)**.

In general, it can be said that the incidence of PROM in patients can be affected by various factors, which can be evaluated based on ultrasound indicators or other diagnostic methods **(40)**. On the other hand, based on the clinical conditions of patients, the experience and skill of the sonologist, as well as some confounding factors, the results of studies can differ, which necessitates planning more comprehensive and complete studies by unifying these factors **(40,41)**.

The limited number of participants and the lack of timely referral and follow-up of necessary tests and examinations were among the most important limitations of this study, which was attempted to be largely overcome by regular and careful follow-up of the patients.

5. Conclusion

Finally, the results of the present study showed that there was a reverse significant relationship between the PI ultrasound index and the 1-minute and 5-minute Apgar scores in pregnant women with PPROM. However, to confirm these findings, it is suggested those further studies with a larger sample size be conducted in the future.

6. Declarations

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The conceptualization, design, data analysis and preparation of this research study. A.S.J and S.H: Conceptualization, study design, literature search; S.D, Z.A and N.F: data collection, literature search, and manuscript writing; B.S, A.A and H.E: statistical analysis and manuscript editing. All authors confirmed the final version of the manuscript.

Ethical Considerations

This study was approved by the ethics committee of Tehran University of Medical Sciences (ethical code: IR.TUMS.MEDICINE.REC.1401.277). All participants gave oral and written informed consent before enrolling in the study.

Authors' Contributions

None.

Conflict of Interest

The author declares that there is no conflict of interest.

Fund or Financial Support

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